

**“SUBSTANTIAL MARGIN OF SAFETY”:  
A NEW APPROACH TO HLW DISPOSITION  
(Paper presented at Waste Management '02, Tucson, AZ)**

Max S. Power  
Washington State Department of Ecology  
Nuclear Waste Program  
(Retired, 2004. Now resident in Corvallis, OR)  
nuguru@peak.org

**ABSTRACT**

In the Spring of 2001, the National Research Council published “Disposition of High-Level Waste and Spent Nuclear Fuel: The Continuing Societal and Technical Challenges.” (1) While finding the technical case for deep geologic disposal of high-level waste and spent fuel robust, the report focused new attention on societal issues and decision-making. The report appeared against a backdrop of heightened controversy about the development of a geologic repository at Yucca Mountain, Nevada.

This paper identifies three principal reasons for the National Research Council committee’s finding that “Difficulties in achieving public support have been seriously underestimated in the past, and opportunities to . . . gain public trust have been missed.” These are:

1. Using language that exacerbates mistrust rather than promoting dialogue and learning;
2. Relying on “go/no-go” decision-making in an area with large uncertainties; and
3. Insufficient attention to iterative and incremental learning and progress.

This paper proposes three specific elements of a strategy for dealing with high-level waste and spent fuel disposition consistent with the National Research Council’s findings and recommendations. The three elements are:

1. Use of the concept “substantial margin of safety” in place of reliance on the usual forms of risk assessment;
2. A more interactive, iterative process to manage both interim storage and long-term disposal; and
3. A step-wise process toward geologic disposal.

The paper also proposes one possible approach to implementing the strategy. If carried out over time, the proposed approach may restore equilibrium between the technical and societal aspects of HLW disposition decision-making. Such an approach may also avoid the loss of time and extreme conflict associated with previous “political” fixes aimed at achieving deep geologic disposal in the United States.

## INTRODUCTION

The National Research Council's Committee on Disposition of High-Level Radioactive Waste found, among other things: (1)

- **“Today the biggest challenges to waste disposition are societal.** Difficulties in achieving public support have been seriously underestimated in the past, and opportunities to increase public involvement and to gain public trust have been missed. Most countries have made major changes in their approach . . . to address the recognized societal challenges. Such changes include initiating decision processes that maintain choice and that are open, transparent, and collaborative with independent scientists, critics and members of the public.”
- **“Whether, when, and how to move toward geological disposal are societal decisions for each country.** This decision process will be lengthy, and the time can be used to improve both the technical and the societal bases for these decisions.”
- **“A stepwise decision process is appropriate for decision making under technical and social uncertainty.”**

The United States has gone, at best, only part way toward the “major changes” sketched in the first finding quoted above. The result is likely to be a repetition of the “political solution” of 1987 that resulted in increased conflict and delay. (2, 3)

There is a better way. That way must do three things:

- Allow scientists, the public and decision-makers to enter into dialogue on a relatively equal basis about risks, solutions, uncertainties and costs;
- Build confidence in a process of mutual learning to guide decisions over time; and
- Focus on reasonable solutions for different time periods.

This paper briefly describes some concrete ways to meet these needs. First and foremost, the language of risk assessment or performance assessment, which now exacerbates public mistrust, must be re-cast, so that it helps promote dialogue about what is known and what is not known—about uncertainty. The next step is to commit to a process that, over time, reduces uncertainties in ways that meet the concerns of many segments of society. Within that process, it is important to focus on what needs to be done in the near term to move to the next step and what can be learned from taking that step to guide subsequent steps.

## “SUBSTANTIAL MARGIN OF SAFETY”

A “substantial margin of safety” (SMS) is defined as that list of factors that give most people involved in a decision confidence that unacceptable harm to persons and the environment will be avoided. This does not imply a “zero risk” approach to high-level waste disposition decisions. It does imply considering a set of concerns and values within a common framework broader than technical risk assessment (though risk or performance assessment will inform the discussion).

### **Language and Perception**

The broader public has difficulty with the techniques, jargon and proper contextual use of risk assessment. Essentially, asking the public to use its tools in decision-making is asking them to hold the conversation on the “experts” ground. In the case of nuclear waste, there are sharp differences between expert and public perceptions. Use of risk assessment fuels distrust rather than aiding practical choices.

One oft-cited survey indicates a strong divergence between “expert” and public perceptions of risk with regard to nuclear waste. (4) The National Research Council Committee’s discussion of performance assessments points out that “The non-expert looking at typical results from PAs will be confused by complex, probabilistically expressed results.” If a substantial body of risk communication literature is to be believed, piling more technical results onto a skeptical public will increase mistrust, not understanding. (5) “Numerical results of analyses extending to geological times, if presented without sufficient discussion of their significance, lead understandably to accusations of over-optimism, hubris, or even irrationality.” (1)<sup>a</sup>

Let us suppose, instead, that a conversation about geologic disposal of high level wastes starts from a more fundamental point. The “experts”, for their part, would describe the materials to be disposed, the reasons why disposal is important, and the state of knowledge about the hazards involved. This is largely “factual”, or descriptive, stuff. It need not and should not mix in reassurance, speculation, or probabilistic analyses.

For their part, “the public”—potentially affected neighbors, including downstream or down-wind communities, American Indian tribes with treaty interests, and regional and national interest groups of all sorts—would bring their questions, concerns, fears and local or specialized knowledge.<sup>b</sup> Now one would have most of the basics needed to start a productive dialogue, which would increase the level of shared knowledge over time.

One further element, however, is needed: There has to be some reason, some urgency to start the conversation in the first place. An official announcement that a government agency is considering locating a nuclear waste repository in a community’s back yard, while generating urgency, will probably not initiate a very productive dialogue. Therefore, the people who have the problem—in this case on-site storage at many reactors—need to engage with those affected by various proposed solutions. Indeed, a constructive approach might well start with the communities affected by present-day storage, and then broaden as the case for geologic disposal becomes more apparent to the participants.

In any case, both groups—those with the problem and those who may inherit it—need to be engaged separately and together in a process to identify relevant facts and issues.

### **Territory for Dialogue and Negotiation**

Practically speaking, these are the steps that will lead to a dialogue about costs, risks, benefits, and, most of all, about the uncertainties surrounding them all. Proponents and affected parties enter the “territory for negotiation.” (6) As presented by Egan, Eddowes and Nixon, this concept

is focused on balancing cost, risk and benefits, both local and national, related to industrial facilities perceived as hazardous. These authors suggest, based on a series of international case studies, that a balance between these factors can be found in negotiations bounded, on the one hand, by legally-defined unacceptable risks and, on the other, by what is affordable.

This is rich territory to deal with uncertainties that surround the risks, costs and benefits of high-level waste disposal. The “substantial margin of safety” is defined by asking: “Given what we don’t know, what would make us comfortable to move ahead?” (At the same time, an iterative process asks: “What would we learn by moving ahead that will reduce the uncertainties?”—a point discussed below.)

Egan et al. suggest the importance of “a process of give-and-take, in which the price to be paid for further risk avoidance is properly exposed as part of the decision process and is balanced with other success criteria.” (7) Such a process takes into account technical information, community values, national needs, costs and public concerns. The “give-and-take” allows all participants to work with the trade-offs among these factors. Within the bounds set by standards of unacceptable risk and unaffordable cost, such a process envisions substantial room for negotiation and even achievement of as much consensus as is possible.

“By contrast,” Egan and his colleagues continue, “if decision making takes place solely with respect to a prescriptive rule-based system, allowing only for ‘go/no-go’ decisions based on the achievement or violation of generic standards, the scope for negotiations will inevitably be very limited.” One might add that it also means that the rules—or standards—themselves become the point of conflict.

In the case of nuclear waste disposal, this inevitably pushes the discussion back into the unequal and distrustful realm of arguments in “the experts’” language. The United States’ experience since the passage of the Nuclear Waste Policy Act suggests, as well, that conflict then focuses on who can set the rules and which rules apply.<sup>c</sup> These arguments divert attention away from the underlying uncertainties about cost, risk and benefit that need to be addressed.

The “substantial margin of safety” concept offers a way to re-enter the territory for negotiation, and to address risk, benefit and cost—and the uncertainties surrounding each—from many perspectives. The concept can be useful within the boundaries set by standards beyond which uncertain outcomes are not acceptable, on the one hand, and cost, technical and practical constraints on the other.

## **DECIDING, ACTING AND LEARNING**

The “substantial margin of safety” concept can be broken into distinct, tangible pieces, each of which may be familiar—or have a familiar analogue, and each of which can be meaningfully assigned a cost. For example, there is a good deal of experience with—and public acceptance of—storage of spent nuclear fuel at reactor sites. The containment, surveillance, security and maintenance activities that give most people near-term confidence that there will not be unacceptable harm to public health and the environment—a substantial margin of safety.

There is ample data about pool storage, and a growing body of experience about dry cask storage. While not directly parallel to commercial spent fuel, the Hanford spent fuel project has produced a wealth of information about safely retrieving, drying and packaging damaged and oxidized fuel from storage basins. Without either being overly technical or unduly fanciful, participants can project how these activities will fare over the relatively near future. Most people understand, in some degree, the limitations of concrete, the maintenance or replacement needs for ventilation and water filtration systems, and the costs and limitations of active security—of guards and guns.

Presumably, too, they can project how both costs and risks can be expected to increase over time, and estimate what additional actions would be required to maintain a “substantial margin of safety”. In fairly concrete terms, then, the case for geologic disposal—assuming it is sound—will begin to emerge.

Meanwhile, the people potentially affected by geologic disposal start from a perception that costs, risks and benefits are very uncertain indeed. From their perspective there are no analogues, no near-at-hand experiences other than those supporting Murphy’s Law (“If anything can go wrong, it will”).

However, there are analogies and concrete things within their experience that may help build confidence. These may take a bit more explaining than purifying water or keeping guards on patrol. But consider some examples:

- Road cuts and natural features abound with visual information about geologic processes;
- Heat and oxidation, and their effects on various materials, have household analogues;
- History and archeology provide a wealth of examples of (mostly near-surface) disposal of both “good” and “bad” items and their eventual fate.

The key here is to let the evidence speak (rather than justify a position), and then to ask what it tells us about the substantial margin of safety. Does the evidence suggest greater confidence (less uncertainty) about certain geologic settings or use of materials? Or does it suggest specific areas where reducing uncertainty is important and can be achieved, over a reasonable time, by further research?

One obvious question provides a point of intersection between the on-site storage and geologic disposal parties of interest. What can be learned during this extended period of surface storage, in both dry and wet conditions, that helps reduce uncertainties or suggest particular safety measures for long-term geologic disposal?

Many “experts” will find all this painfully simple and repetitive. “We’ve already done all that!” will be their cry. This paper suggests, however, that defining the questions and the kinds of information that will help answer them must stem from a dialogue among affected individuals. It cannot appear—as often happens—as self-serving science of a particular industry or social group.

The fact that the substantial margin of safety can be dealt with in relatively concrete, familiar pieces, also means that some of the negotiated measures to provide the margin can be renegotiated or dropped based on experience. For example, the security and escort measures taken for initial shipments of naval submarine reactor compartments to Hanford for disposal, or for initial shipments to the Waste Isolation Pilot Plant have not been continued at the same level of intensity and involvement of state and local officials. The level of confidence in these shipments has risen; the level of uncertainty declined. The substantial margin of safety, as judged by most people, can be maintained with a reduced, though still thorough and significant, level of effort.

In fact, periodic review of the elements negotiated to provide the substantial margin of safety can itself be negotiated. Ideally, such a negotiated review would include some guidance as to what information and criteria would be used in the review.

### **STEP-WISE APPROACH TO GEOLOGIC DISPOSAL**

As the preceding section suggests, pursuing a substantial margin of safety can begin with near-term questions, set an agenda for research and review, and anticipate future questions. This seems quite consistent with a call for step-wise progress toward geologic disposal. Again, the focus can be on reducing those uncertainties that force people, from whatever perspective, out of the “territory for negotiation.”

Here are three examples of potential steps—steps that could be taken simultaneously—to maintain movement based on needs for information arising from negotiations ultimately leading to geologic disposal:

- A “roadmap” could be established by independent scientists to show how and when ongoing studies on seismicity and volcanism throughout the world might be used to reduce uncertainties about particular regions or geologic settings.
- An agency or organization independent of repository advocates or opponents might undertake an evaluation of emerging studies of biological effects of low doses of radiation. One result could be recommendations on how to more precisely define the unacceptable limits that constrain the territory for negotiation.
- A process similar to that described earlier in this paper might be initiated to deal with transportation of spent nuclear fuel and high level waste. Potential corridor communities might be involved in a virtual or electronic series of discussions addressing substantial margin of safety, including current practices and regulations, areas of uncertainty, and special community concerns (such as terrorist diversion). Near-term activities could be used to test proposed measures.

As the western states worked with USDOE to develop protocols for safe and uneventful transportation to the Waste Isolation Pilot Plant, these were used and assessed when other shipments were made, such as shipment of cesium capsules to Hanford. In a similar way,

measures leading to a widely-accepted substantial margin of safety for transportation could be in place and ready to support staging for geologic disposal.

## **POLITICAL CONSIDERATIONS**

One may well argue that the foregoing is “pie in the sky” and that any chance for this kind of dialogue to occur in the United States was missed long ago. In 1989, this author commented on the 1987 Amendments to the Nuclear Waste Policy Act, pointing out:

“Congress left the decision-making to the Secretary of Energy, with participation by other agencies and review by the president and Congress. It was insufficiently prescriptive, however, about how the choice was to be made. When the secretary mismanaged the how, Congress wound up usurping the where.

“Second, Congress provided no basis to measure the ‘success’ of the public process. The political system has not developed the means to identify, debate, weigh, and balance technological risks and benefits in a broadly accepted way.”(2)

Looking back with the added insight of the “territories for negotiation” model, it is clear that Congress also relied heavily on “a prescriptive rule-based system, allowing only for ‘go/no-go’ decisions based on the achievement or violation of generic standards. The result has been ongoing litigation and political rhetoric about which agencies have the authority to set the rules.

To be fair, Congress attempted in the 1987 Amendments Act to open the door to dialogue. The act provided for the Nuclear Waste Negotiator and for creation of the Nuclear Waste Technical Review Board. The first made little progress. It is this author’s impression that it failed largely because the scope was conceived as primarily dealing with compensation packages as opposed to developing an agenda of concerns, information, research and actions that would begin to build a substantial margin of safety—to reduce underlying uncertainties. However, a thorough and systematic review of the negotiators’ efforts would be instructive, and might well suggest this paper’s proposed approach is overly naïve.

The Nuclear Waste Technical Review Board has continued to operate. Again, it is the author’s impression that the Board has fostered whatever fragments of dialogue have occurred. The Board has done a reasonable job of eliciting a range of concerns and suggesting how technical information can be marshaled to meet them. However, it has not clearly stimulated dialogue between the targeted repository community, communities hosting on-site storage, potential interim storage sites and concerned parties along transportation routes. Perhaps its greatest shortcoming, however, is simply that the law and the practices of the Department of Energy do not clearly link the Board’s work to the “territory for negotiation” and the participants therein.

## **A PROPOSAL**

One course to overcome the social and political resistance that the geologic disposal program has experienced in the United States is to pause and to construct a process along the lines suggested here. As Egan and his colleagues argue, that requires some devolution of decision-making. In this case, that probably means suspending for a time key “go/no-go” decisions to allow room for

dialogue and negotiation. But the process cannot go on indefinitely. It must also impose some measures for accountability for all participants—including deadlines by which certain measures to move forward are agreed to. To have credibility, the process must have a legislated base—an assurance of openness, the necessary devolution and success milestones, and an independent convening institution.

There have been many proposals for reforming or replacing the repository siting process in the United States.<sup>d</sup> The following proposal is less sweeping than many—probably the minimum that could be done to correct the failures and implement the strategy described above.

Congress should amend the Nuclear Waste Policy Act to include the following concrete steps to help move the repository debate into more constructive territory:

1. Broaden the charter of the Nuclear Waste Technical Review Board to include a small number of risk communications experts, political scientists and economists selected through an open process.
2. Replace the requirement that DOE submit a license application to the NRC within three years of a site suitability determination with a requirement that the stakeholder process (discussed below) be convened and that the license application will be submitted within five years unless the NWTRB determines that constructive progress can be made by delaying the application on annual basis for an additional three years.
3. Direct the Secretary of Energy (or a successor agent) to convene, through one or more nationally-recognized independent, non-profit organizations, an ongoing dialogue on geologic disposal, involving potentially affected communities, states, tribes and organizations who are affected by on-site storage, transportation, interim storage or eventual disposal.
4. Direct the NWTRB to devise, through a public process, a set of criteria by which to evaluate the success of the dialogue on an annual basis, beginning one year after formal convening of the dialogue, to report on its evaluation to the Secretary and the Congress, and to make recommendations to dialogue participants. The criteria should include measures of effective communication (supporting concepts like “substantial margin of safety” that are designed to improve communication and secure constructive agreement).

The alternative is to press ahead with establishing site suitability for Yucca Mountain and preparing a license application. This appears to be the Administration’s preferred choice. In the near term, however, it appears likely to repeat the “success” of the 1987 amendments, which nominally set back the repository program by ten years. It is possible that some “territory for negotiation” can be carved out in the licensing process; but as things stand, that process is very much a prescriptive “go/no-go” one.

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<sup>a</sup> “The Environmental Protection Agency has declared that the Yucca Mountain repository could be built only if, *during the first 10,000 years of its life*, members of the public would be subjected to no more than 15 millirem of radioactive leaks—about what they get from two weeks of natural and man-made sources. No more than four millirem of it can come from water . . . the EPA said.



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“Leave aside for the moment the question of what they are smoking inside the Beltway that feeds the official fantasy that humans are able to set any safety standard that will be good for 10,000 years. . . .

“The EPA’s conclusion is all well and good. But rational people know that nobody can make any such showing one way or the other. It’s beyond human capability to reliably predict the weather 10 days from now, never mind conditions 10,000 years hence. But this handicap has not deterred those determined to base public policy on exhaustive analysis of fairy dust.” “A 10,000-year nuclear fantasy,” editorial in the Seattle Post-Intelligencer, June 19, 2001.

<sup>b</sup> I recognize that these two sets of information (oversimplified from what would be several different kinds) are not parallel. But both need to be on the table before any real progress can be made. See Spencer Weart, (6), Chapter 16, “The Debate Explodes”.

<sup>c</sup> Note that in June and December of 2001, the State of Nevada went to court to challenge adoption of EPA’s standard for release from a repository and DOE’s guideline for determining site suitability.

<sup>c</sup> See for example James Flynn et al., One Hundred Centuries of Solitude: Redirecting America’s High-Level Nuclear Waste Policy (Boulder: Westview Press, 1995), and D. Dowd Muska, “Spare the Rods: The Free-Market Alternative to the Yucca mountain Repository,” Nevada Policy Research Institute, November 2001

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